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A PETROLOGIC INVESTIGATION OF THE MANLIUS AND COEYMANS LIMESTONES

By

FRANKLIN W. FESSENDEN

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Accorded an A. Cressy Morrison Award in Natural Science in 1959 by The New York Academy of Sciences.

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A PETROLOGIC INVESTIGATION OF THE MANLIUS AND COEYMANS LIMESTONES

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Introduction

The stratigraphic delineation of the boundary between the Manlius
d the immediately overlying Coeymans beds is uncertain. Both forma-
ons are very similar in lithology and appearance and, although the
eymans is recognizable and mappable at a distance as a generally
re resistant unit than the Manlius, the exact boundary between the
o formations is uncertain over an interval of 8 feet. The Manlius has
en placed in the late Silurian and the Coeymans in early Devonian
the use of fossils (Davis, 1953; Ruedemann, 1930; and Goldring, 1933).
evious work in the area (Rickard, 1955; Davis, 1953; Harris, 1904;
edemann, 1930; Vanuxem, 1839; and Clarke and Schuchert, 1899) has
elded little evidence for any kind of boundary, much less the exact
sition of the contact. On the contrary, a transition zone extending
om 4 to 8 feet vertically indicative of interfingering seas has been
stulated (Davis, 1953; Ruedemann, 1930).

I decided to attack the problem of the nature of the contact by petro-
aphic analysis. Samples were collected at intervals of 1 foot from
vertical sections, each extending from known Manlius at the base to
finite Coeymans at the top. The collecting was done from a part of the
lderberg escarpment in John Boyd Thacher Park in eastern New York
ate. FIGURE 1 shows the Helderberg area in relation to surrounding
eas. A total of 94 samples was collected, from which 50 thin sections
d 92 heavy mineral slides were prepared.

Lithology and Stratigraphy

The Helderberg Mountains today are part of the Allegheny Cuesta
oldring, 1933). FIGURE 2 is the stratigraphic column of the beds
cluded in the cuesta. Paleogeographic and stratigraphic references
the following discussion are taken from Schuchert (1955) and from
rsonal field observations, unless otherwise specified. During the early
leozoic, the seas that deposited the sediments found in the Helderberg
ea lapped up against the Adirondack 'old land' (FIGURE 1) forming
wide flat coastal plain. Subsequent erosion of this coastal plain has
moved much material, and a cuesta was formed that retreated southward
m the Adirondack dome.

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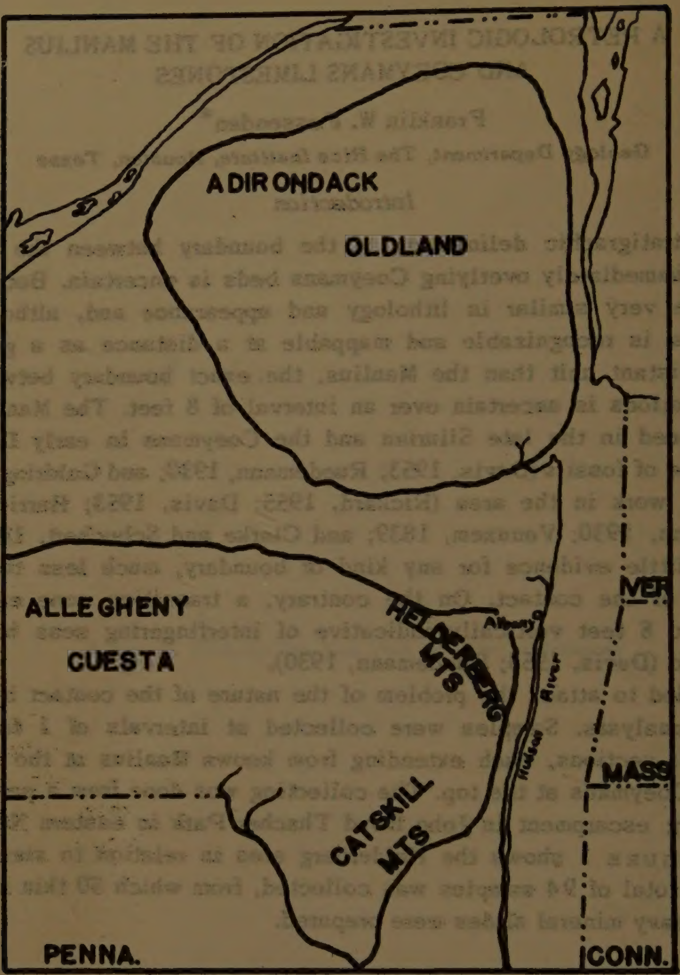


FIGURE 1. Outline map of eastern New York showing Helderberg area in relation to surrounding areas. After Goldring, 1933.

The Late Silurian Mississippian embayment in Louisiana, Mississippi, and Alabama was the source of the Manlius sea, which extended from Louisiana through New York State. During Manlius time the lands surrounding the area were all low-lying, and no tectonic movements occurred. This low-energy environment gave rise to a limestone that is shaly in part. The Manlius is dark blue, thinly bedded, and very pure (85 to 95 per cent carbonate), although there is present 1 bed of thin-bedded, very marly waterlime about 4 feet thick which contains about 30 per cent clay and silt. Many stromatoporoid reefs and other fossils are present in the Manlius, and some workers (Goldring, 1933; Ruedemann, 1930)

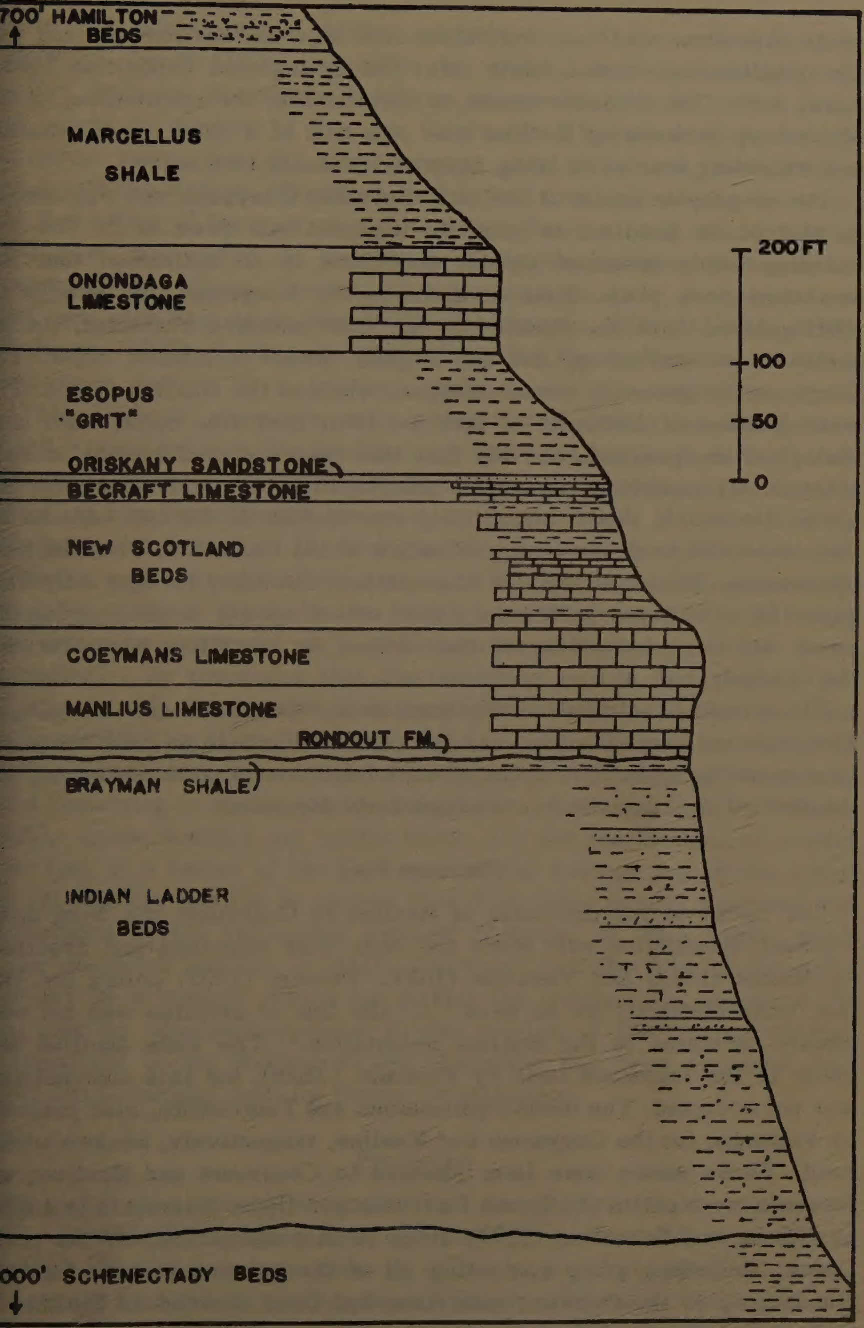


FIGURE 2. Stratigraphic column of the Helderberg escarpment. After Goldring, 33,

state that these reefs are indicative of a lagoonal environment and that the Manlius represents chiefly tidal flat or lagoonal deposition behind coral reefs. The evidence seems to indicate that the environment of the Helderberg area during Manlius time was that of a quiet, warm, shallow sea extending over a flat-lying, temporarily stable land area.

The geographic extent of the early Devonian Coeymans sea was similar to that of the Manlius, as were the deposits laid down in it. The surrounding lands remained stable, and there is no indication that any tectonism took place. From a distance the Coeymans can readily be distinguished from the Manlius by its more massive character, its resistance to weathering, and its slightly darker weathered color. The Coeymans is generally semicrystalline, whereas the Manlius is not. The main features of similarity of both are their dark blue color, their mineralogical composition, and the fact that they are conformable to each other in all aspects of structural relationships. It might seem from the above discussion that a visual field examination of the two beds is all that is needed to deduce the true nature of the transition. Detailed field examination in the vicinity of the contact, however, reveals only very minor local changes in lithology that are of no aid in determining the exact nature and location of the contact or transition zone between the two beds.

The structural relations of the Manlius and Coeymans are very simple. The beds are very flat-lying and are conformable both to each other and to surrounding beds. The strike of each formation is north-northwest, and the dip is 1 or 2 degrees in a southwesterly direction.

Previous Work

The nature of the transition of Manlius to Coeymans has been under constant speculation ever since the beds were examined and described by Mather (1843) and Vanuxem (1839). Prosser (1907) points out this fact quite distinctly as he says "... the line of division was not very clearly indicated in the original description." The name Manlius was given to the limestone beds by Vanuxem (1839), but this nomenclature was not accepted. The terms Pentamerous and Tentaculite, also proposed by Vanuxem, for the Coeymans and Manlius, respectively, became widely used. These names were later changed to Coeymans and Manlius, and the beds were put in the Lower Devonian and Upper Silurian in that order by Clarke and Schuchert (1899). Prior to this classification, the entire Lower Helderberg group containing all of the calcareous beds from the Rondout up to the Oriskany sandstone had been classed as Silurian by Hall (1874). Two to 5 feet of transition beds, indicative of a gradational change rather than a sharp break, were postulated early in this century (Harris 1904) As late as 1924, however, there was no full agreement s to the nomenclature of the subdivisions of the entire Manlius-oeymans. Smith (1924) describes the whole Lower Helderberg group, pplies the name Manlius to the entire succession of beds in that group, nd makes no mention of the term Coeymans. This terminology was the xception rather than the rule, however and, in general, the situation tood with the Manlius classified as Silurian, the Coeymans as Devonian, nd the nature of the contact a moot point. Various local unconformities ave been postulated on the basis of Manlius pebbles found in the oeymans, but these theories have never been fully proved and, at est, are only very local phenomona (Ruedemann, 1930; Goldring, 1933; hadwick, 1927). Ruedemann also offers the theory that the transition eds were formed in a lagoonal environment with oscillating seas.

Until 1953 no extensive work concentrating solely on the problem f the contact between the Manlius and Coeymans had been attempted. At his time, however, Davis (1953) approached the problem by a detailed urvey of the fossiliferous horizons in the two beds. He described the ithology and fauna of 15 stratigraphic sections spaced at intervals long the entire breadth of the outcrop of the Manlius and Coeymans. He ound no distinct break in the fossil assemblage or in the lithology hat could be construed as a definite contact between the two beds. ccordingly, he concluded that the transition was in fact gradual, and e agreed with Ruedemann that oscillation of the seas was the main actor contributing to the formation of the transition beds. A second study f the area utilizing the methods of stratigraphic investigation, especially hose pertaining to environments of deposition, has been made by Rickard 1955), whose findings are briefly these: (1) that the Manlius of central ew York is a facies of the Coeymans of the eastern part of the state; nd (2) that the Manlius of eastern New York thins rapidly westward and s replaced by the thickening Rondout dolomite. In other words, much f the so-called Manlius is really Coeymans, and the Silurian-Devonian oundary is at present placed too high in the stratigraphic sequence. At is time no conclusive answer to the problem of the type of contact r transition of the Manlius to the Coeymans has been proposed, and e question remains open for further investigation.

Procedure

The sites designated for collecting are designated on FIGURE 3 s I, II, and III. Samples were collected from these three sections, ereafter referred to as sections or columns, at 1-foot intervals across e contact from known Manlius through known Coeymans. The top of the aterlime, a very shaly, marly, thin-bedded limestone, generally con-eded to be in the Manlius, was chosen as the datum plane since it is n easily recognized horizon. Twenty samples were collected above

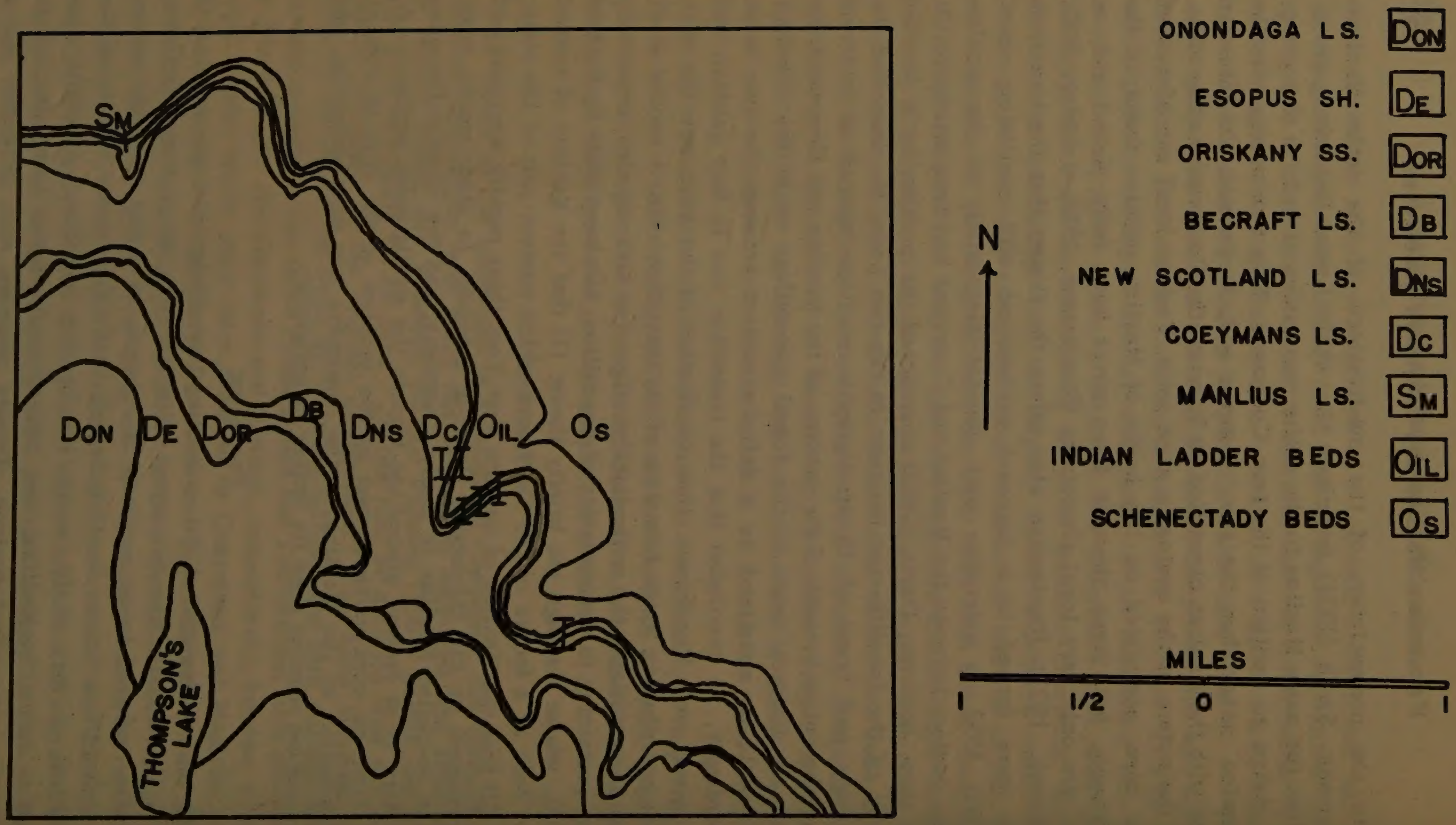


FIGURE 3. Geological map of John Boyd Thacher Park and vicinity, showing sites of sample collection. After Goldring, 1933.

this arbitrary line and 10 below it. In the case of the first column, 15 samples were collected from below the datum. A total of 94 samples was aken. The specimens were numbered in a system whereby the first one below the datum in column I was designated a 1–1–, the second below the datum as 1–2–, the one on the datum as 1–1+, the first above as 1–2+, and accordingly throughout the 3 sections. In this manner 3 suites of rocks, each representative of the transition from Manlius to Coeymans, were collected for further study.

Fifty thin sections were prepared from 50 different samples. The choice of samples for sectioning was made on the basis of variations n lithology. At every point in the vertical section where the lithology changed, a sample was chosen for sectioning. Eighteen samples of column I were chosen and 16 samples each from columns II and III.

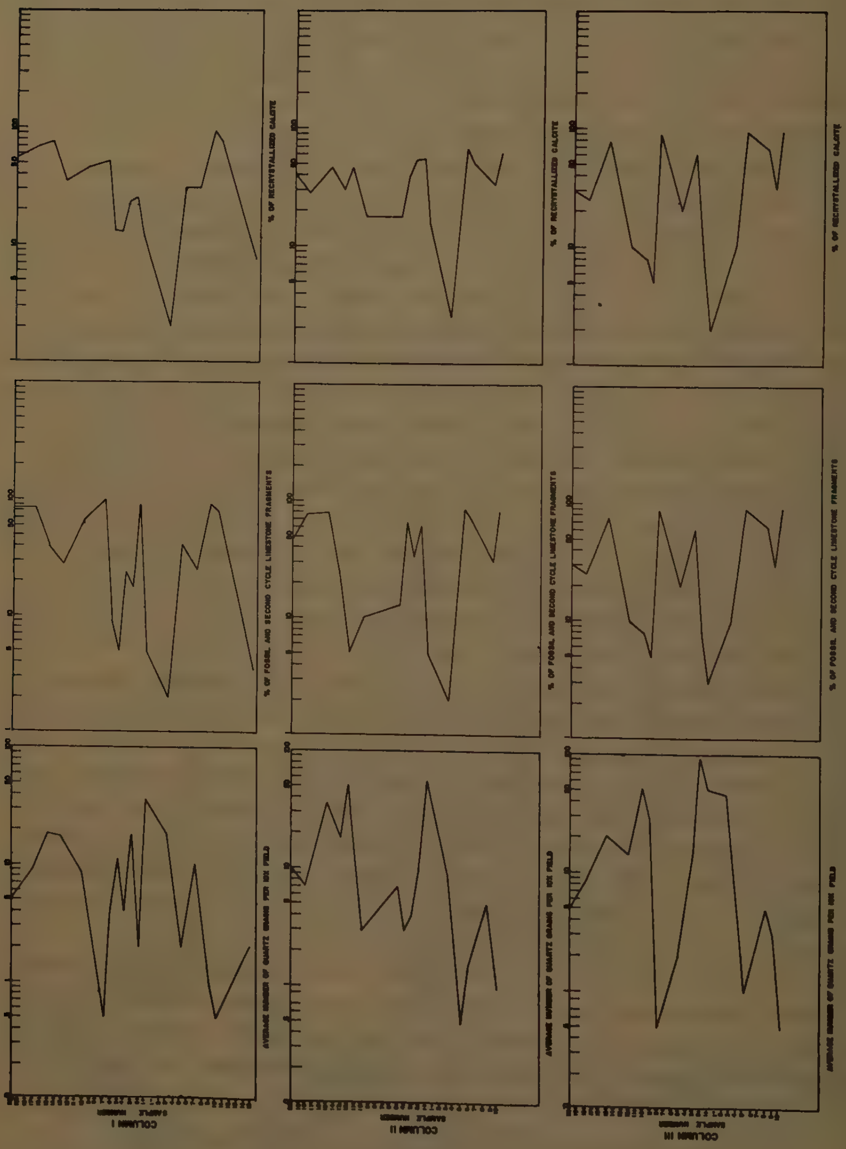
The samples were crushed to –20 mesh and treated with a warm solu-ion of 6 *N* HCl to remove the carbonate. Microscopic examination of the nsoluble residue revealed an excessive amount of clay and silt which, ogether with a coating of iron oxide which stained over 95 per cent f the residue, tended to hinder further examination and identification. tannous chloride was added to the residue to remove the ferrous stain, nd the fine particles of clay and clayey silt were removed by settling he sample in water for a prescribed time and decanting the grains less han 0.01 mm. in diameter. The remaining portion was dried and weighed. n this manner the percentage of insoluble residue minus clay and iron xide was obtained. These results are included in PLATE I.

The heavy minerals were taken from the clay- and silt-free residue by process of centrifuging the sample with bromoform in glass centrifuge ubes. Following the separation, the tubes were placed in dry ice, and nly the lower portion of the tubes containing the heavy fraction were llowed to freeze. The light minerals in the unfrozen bromoform were oured off, and the tubes were washed with acetone to remove any grains dhering to the sides. The frozen bromoform with the heavy minerals as allowed to melt and then poured onto filter paper, drained, washed, nd dried.

The heavy fraction was then weighed. The percentage by weight of he heavy mineral fraction of the sample was then calculated and is ecorded on PLATE 1. Balsam slides of the heavy minerals from 92 amples were prepared. No slides were made from samples 2–4–and 3–16–.

Discussion and Results of Heavy Mineral Slide Investigation

Zircon, tourmaline, barite, apatite, and epidotized plagioclase are the ost abundant and consistent minerals present in the samples. These inerals are generally small, averaging about 0.02 mm. in long diameter,


% OF RECRYSTALLIZED CALCITE
% OF FOSSIL AND SECOND CYCLE LIMESTONE FRAGMENTS
AVERAGE NUMBER OF QUARTZ GRAINS PER 10X FIELD
100
50
10
5
SAMPLE NUMBER
COLUMN I
COLUMN II
COLUMN III

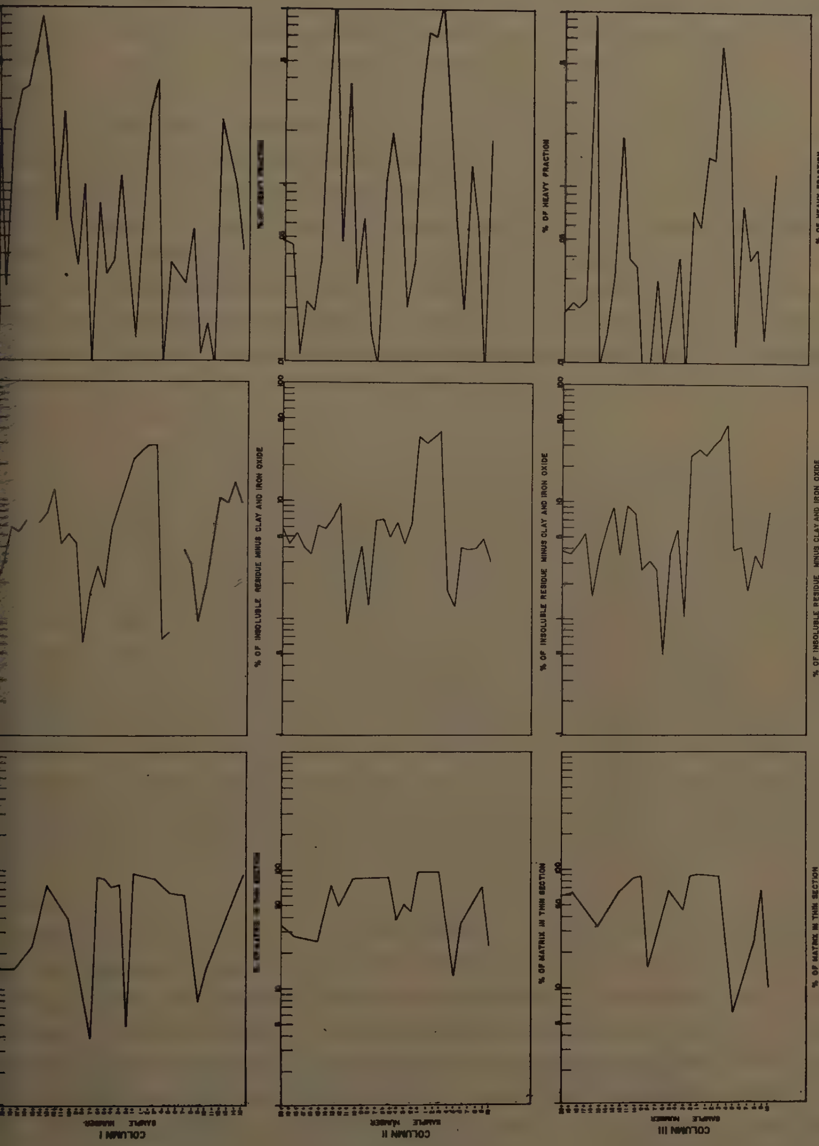


PLATE I

GRAPHIC REPRESENTATION OF LITHOLOGIC VARIATIONS ACROSS THE MANLIUS-COEYMANS CONTACT and are moderately to well rounded. Zircon is present in all of the samples, and tourmaline in all but two. Apatite, barite, and plagioclase-epidote are found in about 80 per cent of the slides. The grains of zircon are generally very well rounded, although some exhibit subhedral prism faces. Tourmaline is generally subhedral and rounded. Apatite is well rounded in all of the slides, owing possibly to the effects of the treatment with HCl. Barite is small and well rounded. In 3 of the slides however, 1–4–, 2–5–, and 3–5–, the barite grains are relatively large, ranging from 4 to 10 times the average grain size of 0.02 mm. Several of the large barite grains in 1–4– have fretted, sawtooth surfaces.

The very small sizes of the heavy minerals and the presence of a heavy coating of iron oxide on many samples made any attempt at precise evaluation of percentages impossible. As a result, the abundance of each mineral in each of the slides was simply estimated visually, and determinations of rare, common, and abundant were made. These results are plotted in PLATE II in the form of bar graphs.

Discussion and Results of Thin-Section Analysis

Fifty thin sections were examined through a polarizing microscope. The petrologic features chosen for study were: (1) relative quartz content; (2) amount of fossil and second-cycle limestone fragments; (3) amount of recrystallized calcite; and (4) amount of matrix.

The relative quartz content was obtained by counting the number of quartz grains per 60 × field and averaging the results for each thin section. The percentages of the other features studied were all estimated visually. The results of the analyses were plotted on semilog paper and are presented in PLATE I. In studying the graphs it must be kept in mind that, although the curves are continuous, data have been plotted for only those samples for which thin sections were prepared. The graphs of total residue and heavy residue have been plotted for all of the samples.

Conclusions

It is concluded from the petrologic investigations discussed in this paper that the nature of the contact between the Manlius and Coeymans beds is transitional and that the deposition in the Helderberg area was continuous from late Silurian through early Devonian time. It was my hope that the graphs in PLATES I and II would show some definitive variations in maxima and minima or other feature that might be indicative of a definite change in the depositional environment of the area. If such a change became apparent, it could serve as a basis for a tentative demarcation of a boundary between the two formations. Such a hypothesis would of course proceed from the questionable assumption that distinct ianges in the depositional history and sedimentary properties are alid criteria for determination of interformational boundaries. No such efinite peaks or other variations were found, however, and the conclu-ion is that the beds are in fact transitional with no predominant evidence a recognizable change in the depositional history present to indicate e exact place in space and time of the change from the Manlius to e Coeymans.

The petrologic character of one of the horizons, however, is worthy further consideration. Concentrations of barite grains much larger an the average occur in the mineral slides from samples 1–4–, 2–5–, and -5–. These 3 samples constitute a horizon just below the waterlime eds. The barite grains range in average size from 0.08 mm. to 0.02 mm., d some are as large as 0.06 mm. in diameter. These sizes are in contrast an average barite grain diameter of about 0.02 mm. in other samples. he fact that the large grains are present in one and only one horizon, d that they occur immediately below the waterlime suggests a relation-ip between the two.

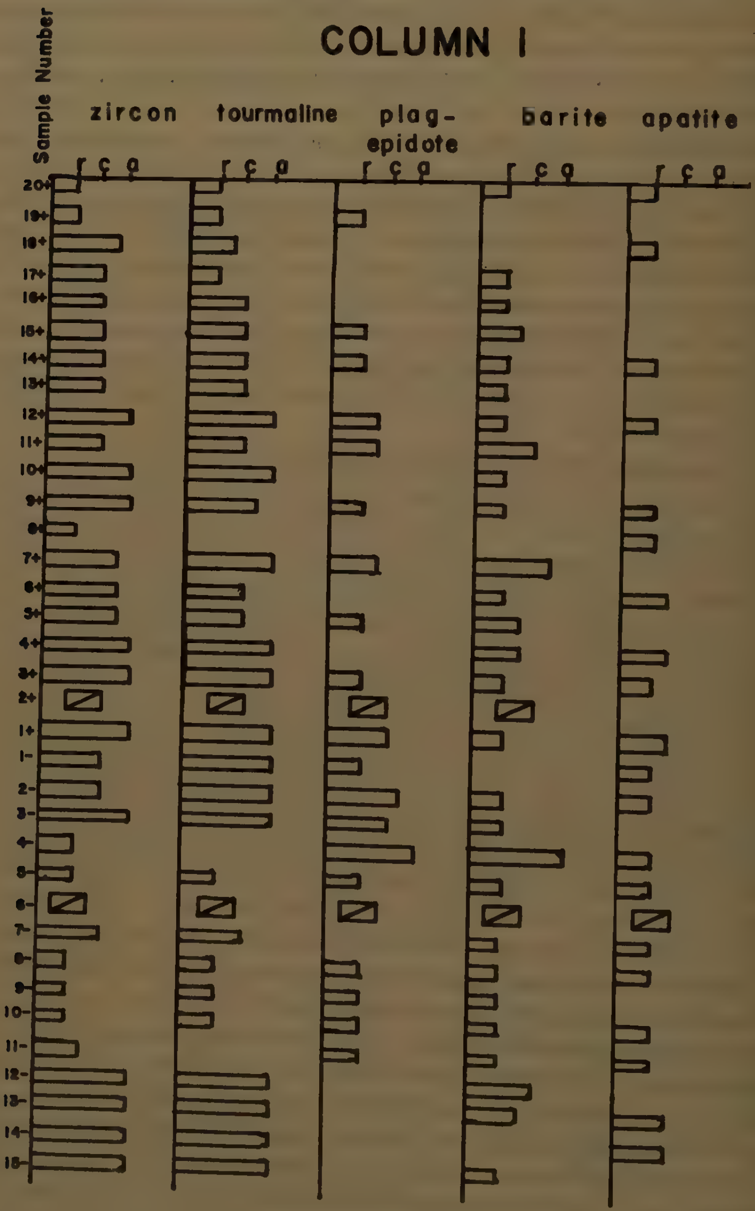
A hypothesis to explain the relationship between the barite grains d the waterlime beds might be derived from an analysis of the effect an erosional interval on the sedimentation in the area. If deposition the limestone ceased upon regression of the sea, erosion and subaerial eathering would tend to remove the easily eroded carbonate material d leave a residuum of noncalcareous silt and clay. Barite grains ould not be affected by weathering and erosion because of its lack solubility (Tarr, 1933, p. 267) and its specific gravity of 4.5. As the osion continued, a concentration of barite grains would build up in the sidual clay and silt. As the sea readvanced, the clay and silt would reworked and deposited with the calcium carbonate as a very clayey, lty limestone or marl. The barite with its high specific gravity would ettle out first and be deposited at the base of the marly waterlime. The sidual barite grains would serve as seeds or nuclei for barium ions ought in by the sea and thus would grow in size to be much larger an the average. When all of the residual clay and silt was deposited, e waters would clear again and lay down the very pure limestone pical of the Manlius and Coeymans sequence.

This hypothesis agrees with the evidence produced by the petrologic vestigation of the Manlius and Coeymans limestones and offers some sis for the placing of the contact between the 2 formations at the se of the waterlime, thus lowering the boundary from about 4 to 10 feet. his lowering of the contact is in partial accord with Rickard (1955). believe that much more work is needed to support this theory, which presented only as one possible explanation for the evidence found d perhaps to serve as a base for further study. One of the avenues of

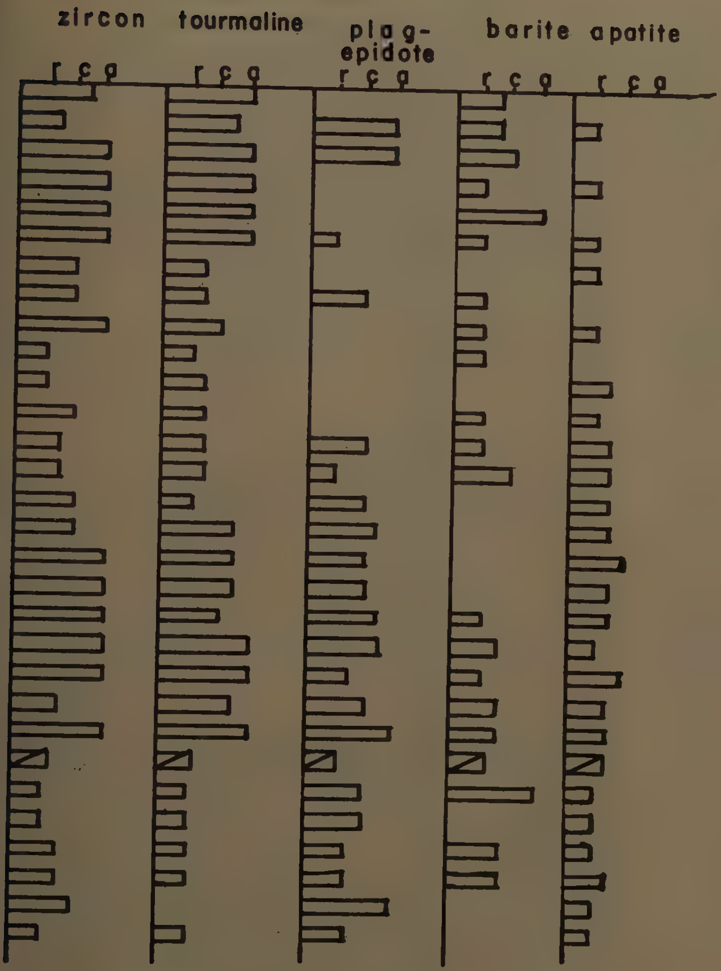
PLATE II

ABUNDANCE OF HEAVY MINERALS

COLUMN I



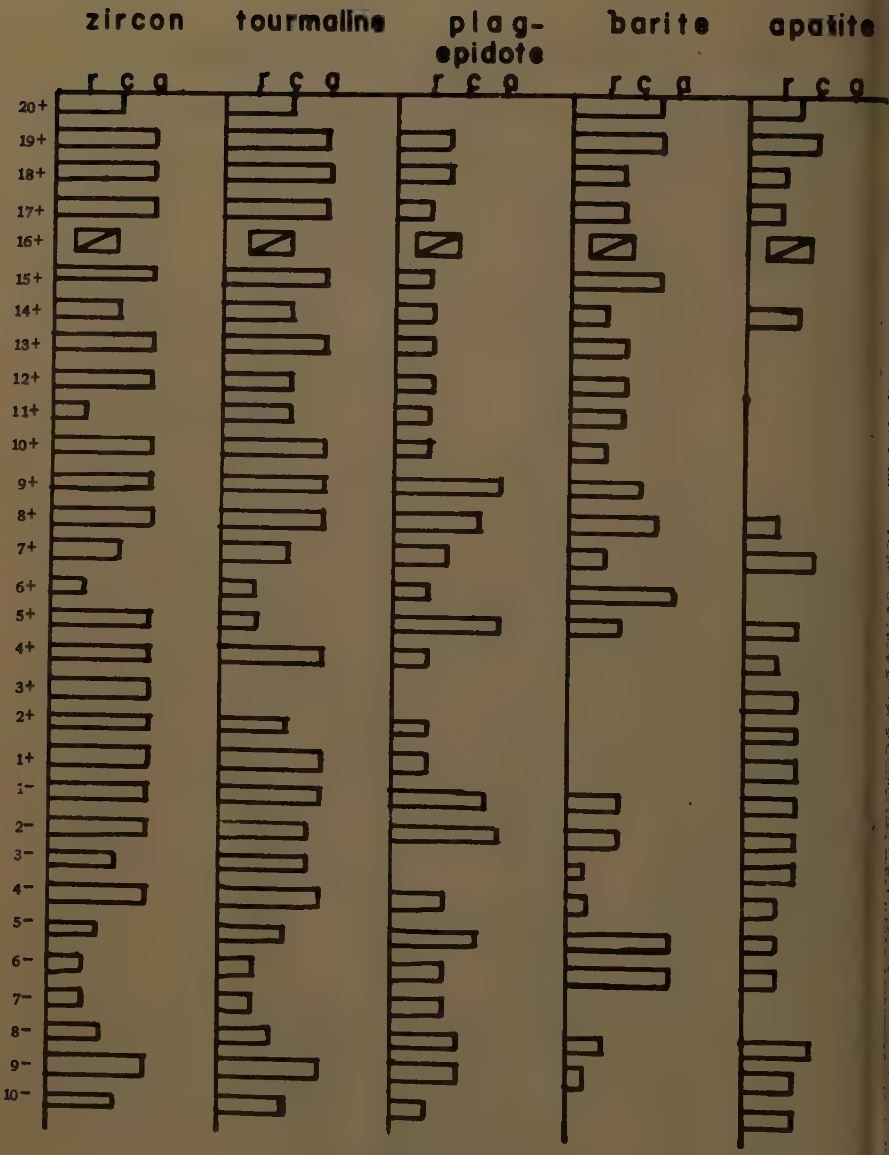
COLUMN II



KEY	
r	RARE
c	COMMON
a	ABUNDANT
▨	NOT REPORTED

PLATE II (Continued)

COLUMN III



vestigation that is recommended is an analysis of the clays of the aterlime and of the whole section of the Manlius and Coeymans beds. ray and chemical data on these clays should shed some penetrating ght on the subject in that knowledge of the composition and structure the clays might furnish a clue to their mode of formation and deposional history. A survey of the entire critical horizon should be underken to determine whether or not the barite concentration is present roughout the entire outcrop or is confined to the John Boyd Thacher rk area.

Summary

A petrologic investigation consisting of thin section and heavy mineral ide analyses of 94 samples taken across the contact of the Manlius and eymans formations leads to the conclusion that the contact is transinal. Continuous deposition is inferred for late Silurian through early evonian time in the Helderberg area. A concentration of large barite ains in a horizon immediately below the waterline beds was observed ich might, upon further study, yield more information about the nature the transition zone.

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